GHG Emissions Summary by Source — Emissions Summary

Hydrogen Energy California (HECA) — *10/28/2009*

GHG emissions are numerically depicted as metric tons (tonne) of carbon dioxide equivalents (CO_2e). CO_2e represents CO_2 plus the additional warming potential from CH_4 and N_2O. CH_4 and N_2O have 21 and 310 times the warming potential of CO_2, respectively.

Natural Gas GHG Emission Factors						Diesel GHG Emission Factors				
CO_2 =	52.78	kg/MMBtu =	116.36	lb/MMBtu		CO_2 =	10.15	kg/gal =	22.38	lb/gal
CH_4 =	0.0059	kg/MMBtu =	0.013	lb/MMBtu		CH_4 =	0.0003	kg/gal =	0.001	lb/gal
N_2O =	0.0001	kg/MMBtu =	0.00022	lb/MMBtu		N_2O =	0.0001	kg/gal =	0.0002	lb/gal

CO_2, CH_4, and N_2O emission factors are taken from Appendix C of the California Climate Action Registry (CCAR) General Reporting Protocol Version 2.2 (March 2007)

HRSG Stack - Burning Natural Gas

Operating Hours		2628	hr/yr			
HRSG Heat Input		1,998	MMBtu/hr			
CO_2 =	277,210	tonne/yr				
CH_4 =	31	tonne/yr =	651	tonne CO_2e/yr		
N_2O =	0.53	tonne/yr =	163	tonne CO_2e/yr	Total tonne CO_2e/yr =	278,023

Startup and shutdown of the HRSG will be accomplished using natural gas. The total operating hours, including startup and shutdown, are estimated at 2628 hr/yr for the worst-case greenhouse gas emissions from natural gas combustion. The total startup and shutdown duration are estimated at 50 hr/yr for the worst-case criteria pollutant emissions.

HRSG heat input rate is assumed to be the maximum heat input rate firing natural gas, which corresponds to winter minimum (20 F).

HRSG Stack - Burning Hydrogen-Rich Fuel

				Syngas GHG Emission Factors		
Operating Hours	5,694	hr/yr				
HRSG Heat Input	2,432	MMBtu/hr		CO_2 =	28.1	lb/MMBtu
CO_2 =	176,445	tonne/yr		Total tonne CO_2e/yr =		176,445

Startup and shutdown of the HRSG will be accomplished using natural gas. The total operating hours, including startup and shutdown, are estimated at 2628 hr/yr for the worst-case greenhouse gas emissions from natural gas combustion. The total startup and shutdown duration are estimated at 50 hr/yr for the worst-case criteria pollutant emissions.

HRSG heat input rate is assumed to be the maximum heat input rate firing Hydrogen-rich Fuel, which corresponds to winter minimum (20 F).

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Auxiliary Boiler

Operating Hours		2,190	hr/yr			
HRSG Heat Input		142	MMBtu/hr			
CO_2 =	16,418	tonne/yr				
CH_4 =	2	tonne/yr =	39	tonne CO_2e/yr		
N_2O =	0.03	tonne/yr =	10	tonne CO_2e/yr	Total tonne CO_2e/yr =	16,466

Emergency Generators

Operating Hours		50	hr/yr			
HRSG Heat Input		2,800	Bhp			
CO_2 =	3,201	lb/hr =	73	tonne CO_2/yr		
CH_4 =	0.09	lb/hr =	0.045	tonne CO_2e/yr		
N_2O =	0.03	lb/hr =	0.2218	tonne CO_2e/yr	Total tonne CO_2e/yr* =	146

The following conversions were used to convert from lb/gallon to lb/hp-hour; and then multiplying by the rated horsepower rating: 1 gallon/137,000 Btu; and 7,000 Btu/hp-hour.

* Total tonnes CO_2e per year represent the contributions from both generators.

Fire Water Pump

Operating Hours		100	hr/yr			
HRSG Heat Input		556	Bhp			
CO_2 =	636	lb/hr =	29	tonne CO_2/yr		
CH_4 =	0.02	lb/hr =	0.018	tonne CO_2e/yr		
N_2O =	0.01	lb/hr =	0.0881	tonne CO_2e/yr	Total tonne CO_2e/yr =	29

The following conversions were used to convert from lb/gallon to lb/hp-hour; and then multiplying by the rated horsepower rating: 1 gallon/137,000 Btu; and 7,000 Btu/hp-hour.

GHG emissions are numerically depicted as metric tons (tonne) of carbon dioxide equivalents (CO_2e). CO_2e represents CO_2 plus the additional warming potential from CH_4 and N_2O. CH_4 and N_2O have 21 and 310 times the warming potential of CO_2, respectively.

Gasification Flare

Pilot Operation						
Operating Hours		8,760	hr/yr			
HRSG Heat Input		0.5	MMBtu/hr			
CO_2 =	231	tonne/yr				
CH_4 =	0.03	tonne/yr =	0.5	tonne CO_2e/yr		
N_2O =	0.0004	tonne/yr =	0.1	tonne CO_2e/yr	Total tonne CO_2e/yr =	232
Flaring Events						
Total Operation		115,500	MMBtu/yr			
CO_2 =	6,098	tonne/yr				
CH_4 =	0.7	tonne/yr =	14	tonne CO_2e/yr		
N_2O =	0.01	tonne/yr =	4	tonne CO_2e/yr	Total tonne CO_2e/yr =	6,116

GHG emissions from flaring events are conservatively estimated using GHG emission factors for natural gas combustion.

GHG emissions are numerically depicted as metric tons (tonne) of carbon dioxide equivalents (CO_2e). CO_2e represents CO_2 plus the additional warming potential from CH_4 and N_2O. CH_4 and N_2O have 21 and 310 times the warming potential of CO_2, respectively.

SRU Flare

Pilot Operation						
Operating Hours		8,760	hr/yr			
HRSG Heat Input		0.3	MMBtu/hr			
CO_2 =	139	tonne/yr				
CH_4 =	0.02	tonne/yr =	0.3	tonne CO_2e/yr		
N_2O =	0.0003	tonne/yr =	0.08	tonne CO_2e/yr	Total tonne CO_2e/yr =	139
Flaring Events (assist gas)						
Operating Hours		6	hr/yr			
HRSG Heat Input		36	MMBtu/hr			
CO_2 =	11	tonne/yr				
CH_4 =	0.001	tonne/yr =	0.03	tonne CO_2e/yr		
N_2O =	0.00002	tonne/yr =	0.007	tonne CO_2e/yr	Total tonne CO_2e/yr =	11
Throughput (inerts)						
H_2S =		25	%			
CO_2 (inerts) =		75	%			
H_2S =		72	lbmol/hr			
CO_2 (inerts) =		216	lbmol/hr			
CO_2 (inerts) =		9,488	lb/hr			
Operating Hours		6	hr/yr			
					Total tonne CO_2e/yr =	26

GHG emissions from flaring events are conservatively estimated using GHG emission factors for natural gas combustion.

Throughtput (inerts) amount calculated from the relationship of CO2 to H2S in the SRU Flare.

GHG emissions are numerically depicted as metric tons (tonne) of carbon dioxide equivalents (CO_2e). CO_2e represents CO_2 plus the additional warming potential from CH_4 and N_2O. CH_4 and N_2O have 21 and 310 times the warming potential of CO_2, respectively.

Rectisol Flare

Pilot Operation						
Operating Hours		8,760	hr/yr			
HRSG Heat Input		0.3	MMBtu/hr			
CO_2 =	139	tonne/yr				
CH_4 =	0.02	tonne/yr =	0.3	tonne CO_2e/yr		
N_2O =	0.0003	tonne/yr =	0.08	tonne CO_2e/yr	Total tonne CO_2e/yr =	139

GHG emissions from flaring events are conservatively estimated using GHG emission factors for natural gas combustion.

Tail Gas Thermal Oxidizer

Process Vent Disposal Emissions						
Operating Hours		8,760	hr/yr			
HRSG Heat Input		10	MMBtu/hr			
CO_2 =	4,625	tonne/yr				
CH_4 =	0.52	tonne/yr =	10.9	tonne CO_2e/yr		
N_2O =	0.0088	tonne/yr =	2.7	tonne CO_2e/yr	Total tonne CO_2e/yr =	4,638
SRU Startup Waste Gas Disposal						
Operating Hours		300	hr/yr			
HRSG Heat Input		10	MMBtu/hr			
CO_2 =	158	tonne/yr				
CH_4 =	0.018	tonne/yr =	0.37	tonne CO_2e/yr		
N_2O =	0.00030	tonne/yr =	0.093	tonne CO_2e/yr	Total tonne CO_2e/yr =	159

GHG emissions from flaring events are conservatively estimated using GHG emission factors for natural gas combustion.

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Intermittent CO_2 Vent

Operating Hours	504	hr/yr
CO_2 Emission Rate	656,000	lb/hr

Total tonne CO_2e/yr =	150,011

Assumes 21 days per year venting at full rate.

Gasifier Warming

Operating Hours		1,800	hr/yr			
HRSG Heat Input		18	MMBtu/hr			
CO_2 =	1,711	tonne/yr				
CH_4 =	0	tonne/yr =	4	tonne CO_2e/yr		
N_2O =	0.00	tonne/yr =	1	tonne CO_2e/yr	Total tonne CO_2e/yr =	1,716

Total tonne CO_2e/yr =	**634,296**